Al Rasheed College of Dentistry
Oral Histology
Dr. Omar Faridh Fawzi
Lecture 4

Dentinogenesis (Dentin Formation)

Dentin is formed by cells called odontoblasts that differentiate from ectomesenchymal cells of the dental papilla following an organizing influence from the inner enamel epithelium. Thus the dental papilla is the formative organ of dentin and eventually becomes the pulp of the tooth, a change in terminology generally associated with the moment dentin formation begins.

Before odontoblasts differentiation, the dental papilla cells are small and undifferentiated, and they exhibit a central nucleus and few organelles. At this time, they are separated from the inner enamel epithelium by cell free zone that contains some fine collagen fibrils.

Almost immediately after cells of the inner enamel epithelium change in polarity, the ectomesenchymal cells adjoining the cell free zone rapidly enlarge and elongate to become preodontoblasts first and then odontoblasts as their cytoplasm increases in volume to contain increasing amounts of protein-synthesizing organelles. The cell free zone between the dental papilla and the inner enamel epithelium gradually is eliminated as the odontoblasts differentiate and increase in size and occupy this zone.

As the odontoblasts differentiate they change from an ovoid to a columnar shape, and their nuclei become basally oriented (pulp direction). Odontoblastic processes arise from the apical end of the cell in contact with the basement membrane. The length of the odontoblast then increases to approximately **40 µm, although its width remains constant (7 µm)**.

Dentinogenesis is actually begins before the start of enamel formation, and unlike amelogenesis, it occurs throughout the life of the individual.

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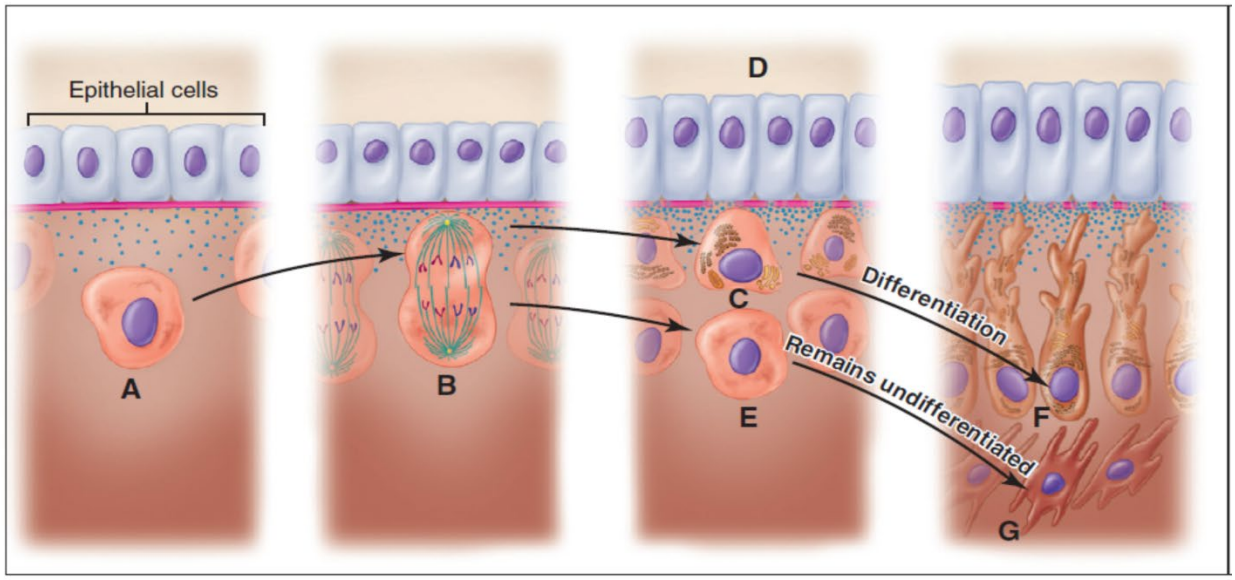


Dentinogenesis occur by odontoblasts in two stages:

1. Formation of dentin matrix (Predentin).
2. Mineralization of predentin.

Formation of dentin matrix(predentin):

The odontoblast cells begin to secrete an unmineralized dentine matrix. This dentine matrix formed prior to mineralization is termed predentine. As more dentine matrix is deposited, the odontoblast cells retreat in the direction of the pulp leaving an elongated process known as the odontoblast process. A narrow layer of predentine is always present on the surface of the pulp.

Korff`s fibers have been described as the initial dentin deposition along the cusp tips, which are large diameter **(0.1-0.2 µm)** collagen fibrils (type III).

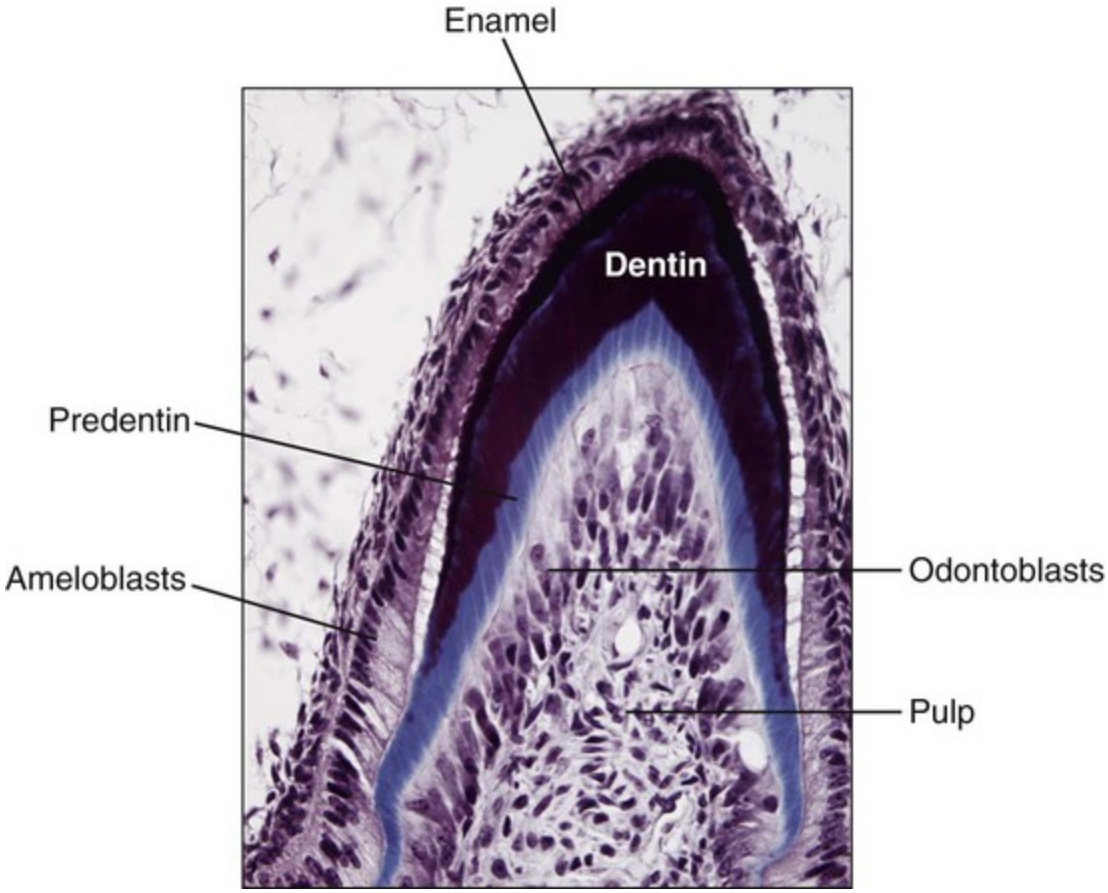
They are bundles of collagen fibrils among the odontoblasts and they are perpendicular to the basement membrane and attached to it. This type of fibers layer is main part and only present in **mantle D.**

Then the korff`s fibers fade gradually and smaller fibrils **type I** collagen that orient themselves parallel to future D.E.J. form a network in the dentin subsequent to the mantle dentin, which called the **circumpulpal D.**

The odontoblasts form the main components of the predentin , the **collagen fibers and non-collagenous protein**. The main non-collagenous proteins in the predentin are:

1. Bone morphogenic proteis (BMP 2,4 ,7)
2. Dentin phosphoprotein (DPP)
3. Osteocalcin, Osteonectin and Osteopontin
4. D. sialoproteins (DSP)

DPP and DSP represent the major non-collagenous protein in D. because they are important for organization and mineralization of predentin.



Mineralization of the predentin

It occurs parallel to predentine formation. It begins at the tip of the crown and then it proceeds in a rhythmic pattern to gradually complete cervically. Mineralization of

dentine begins when the predentine is approximately 5 μm thick. Spherical zones of hydroxyapatite called **calcospherites** are formed within the predentine. Mineralization of the dentine matrix starts at random points and eventually these calcospherites fuse together to form mineralized dentine.

Dentinal tubules will form around each odontoblastic process. The first layer of predentin begins its mineralization called **Mantle dentin** and it occur in a **globular pattern**, where small centers of calcification spread concentrically until they fuse together as calcospherites. This mineralization occurs by budds off small **matrix vesicles** (an electron microscopical budding in cell membrane of odontoblasts contain the first hydroxyapatite crystals and alkaline phosphatase enzyme) which lie superficially near the basement membrane. Mineral phase first appears within the matrix vesicles as single hydroxyapatite crystals. Crystals grow and rupture of matrix vesicle occur and fuse of crystals with adjacent crystals to form a continuous layer of mineralized dentin matrix.

The mineralization goes then in **linear** or occasionally globular pattern in the remnant or bulk thickness of dentin which is called **circumpulpal dentin**. The mineralization begins by crystal deposition in form of fine plates of hydroxyapatite crystals on the surface of the collagen fibrils. The long axes of the crystals are paralleling to the collagen fibrils.

If somewhere those globules do not fuse together, areas of uncalcified dentin are known as **interglobular dentin**.

Formation of root dentin:

Hertwigs root sheath initiate the differentiation of odontoblast that form root dentin. The collagen fibers align parallel to basement membrane in mantle dentine (near the cementodentinal junction)of the root. Also the degree of mineralization is less and the rate of deposition is slower in root dentin than that in crown dentin.

Clinical considerations:

Disturbances in either the secretion or maturation of the dentin matrix can lead to defects in dentin structure, and as a consequence to the supportive function of dentin.

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Three different types of inherited defects in dentin matrix are classed under the term **dentinogenesis imperfecta**. In these individuals, the crowns are found to have a bulbous contour and the pulp chambers become obliterated by poor quality dentin. Clinically, this results in a bluish or brownish cast to the teeth, and shortly after eruption the enamel fractures away leaving the soft inner core of dentin exposed.